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CODE OF PRACTICE FOR VENTILATION OF SURFACE HYDEL POWER STATIONS

(First Revision)

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Hydroelectric Power House Structures Sectional Committee, BDC 59

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0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 14 January 1982, after the draft finalized by the Hydroelectric Power House Structures Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 This standard was first published in 1968. Since then more experience has been gained in the field and to reflect the latest practices the present revision has been taken up. In this revision, requirements of natural ventilation with the provision of windows and ventilators have been included.

0.3 Due consideration should be given to the ventilation requirements in designing surface hydel power stations. Provision for ventilation becomes necessary in the power station building to provide for any or all of the following purposes:

a) To prevent temperature stratification,

b) To remove contaminated or vitiated air,

c) To remove waste heat from generators,

d) To provide for cooling or heating of building,

e) To furnish clean/tempered air, and

f) To furnish outside air necessary for human comfort.

0.3.1 Ventilation in surface hydel power stations by natural means alone using gravity may be sufficient in some stations to meet the above mentioned purposes. Where these purposes cannot be met by natural ventilation, forced ventilation or combination of the two with heating and cooling systems, where necessary, may be resorted to ensure clean, and if necessary, tempered air to reach various premises in the power station, which will, otherwise, receive little or no ventilation and where,

for the protection of equipment and to maintain satisfactory thermal environments, the heat to be removed is too great to be handled by gravity.

0.4 In the formulation of this standard, due weightage has been given to international co-ordination among the standards and practices prevailing in different countries in addition to relating it to the practices in the field in India. This requirement has been met by deriving assistance from the following publications:

ASHRAE guide and data book 1977. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., New York.

United States of America. Department of the Interior and Bureau of Reclamation. Design Supplement No. 6 Turbine and pumps. Government Printing Office, Washington.

United States of America. Department of the Interior and Bureau of Reclamation. Design Supplement No. 8 Miscellaneous mechanical equipment and facilities. Government Printing Office, Washington.

0.5 This standard is one of a series of Indian Standards on surface hydel power stations. Other standards so far published in this series are:

IS : 4247 (Part I)-1978 Code of practice for structural design of surface hydel power stations: Part I Data for design (*first revision*).

IS : 4461-1979 Code of practice for joints in surface hydroelectric power stations (*first revision*).

IS : 4721-1968 Code of practice for drainage and dewatering of surface hydel power stations.

0.6 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers basic requirements regarding design of ventilation system for surface hydel power stations.

*Rules for rounding off numerical values (revised).

1.1.1 For installation, operation, testing and maintenance of ventilating system reference may be made to IS : 3103-1975*.

1.2 This standard, however, does not cover the requirements for ventilation of generators or other equipment and specifications for fans, ducts and other equipment used in the ventilation of surface hydel power stations.

2. TYPES OF VENTILATION

2.1 The ventilation may be of following types:

a) Natural, that is, by forces set in motion by the heat of sun, namely, winds; and

b) Forced or artificial, that is, by extraction or propulsion.

3. GENERAL RULES FOR DESIGN

3.1 Natural Ventilation

3.1.1 Thorough ventilation of power house building should be aimed at by the provision of adequate windows and ventilators.

3.1.2 *Provision of Windows and Ventilators* — The object of providing windows and ventilators is two-fold, that is, to get fresh air and light. The minimum area of windows and ventilators to be provided in power house building shall be one-tenth of the floor area. However, efforts should be made to increase it to one-fifth of the floor area. Windows should be well distributed and be located on windward side at low level and should not, as far as possible, be obstructed by adjoining structures or partitions. When wind direction is variable, windows should be provided on all sides, if possible. Effort should be made to develop cross-ventilation. For protection against fire, it is preferable to provide steel doors and windows in power house and auxiliary rooms. Reference may be made to IS : 1038-1975† and IS : 1361-1978‡. The ventilators should be fixed as high as possible for proper expulsion of warm air. Full advantage should be taken of sunshine which is important in ventilation its availability depends on the orientation of the power house which in turn may depend on site condition. In providing openings, measures to guard against entry of birds, moths, etc, should be taken.

3.2 Forced Ventilation

3.2.1 Forced ventilation system is designed keeping the inlet fan capacity 10 percent more than the exhaust fan capacity.

*Code of practice for industrial ventilation (*first revision*).

†Steel doors, windows and ventilators (*second revision*).

‡Steel windows for industrial buildings (*first revision*).

3.2.2 Unassigned rooms and storage rooms should be carefully considered, so that sufficient ventilation may be provided in those which might be used for purpose requiring additional ventilation in the future.

3.2.3 In portions of the power station building where moisture condensation is anticipated, dehumidified air should be supplied to prevent condensation, as condensation causes deterioration of point, corrosion of metal surfaces and breakdown of insulation on electrical equipment.

3.2.4 The quantity of air required for the power station building should be worked out from the number of air changes preferred for the various premises of the building as given in Table 1. In addition to this the points given in 3.2.4.1 to 3.2.4.9 should also be kept in mind.

TABLE 1 PREFERRED NUMBER OF **AIR CHANGES**

Power House Premises	Preferred Air Changes per Hour
Main generator room, dark room, light and heavy storage rooms, dewatering and drainage sumps, record room	2
Passage, approach gallery, pipe gallery, ventilation equipment room, governor gallery, cable gallery, dewatering drainage-pump room or gallery	4
Oil storage and oil purification rooms, service (pump) gallery, oil sludge room, compressor room, terminal board room, machine shop, tool room, pipe shop, electrical laboratory, fan room, battery room, telephone and communication equipment room	6
All offices, reception room, toilets, shower, kitchen, first-aid room and control room	8

3.2.4.1 One air change per hour means that the quantity of air equivalent to the total volume of the room is supplied to and exhausted from the room each hour. This air may be all outside air or a part of the circulated air, depending upon the oxygen content.

3.2.4.2 The proportion of outside air to the circulated air supplied to a room depends upon temperature conditions, number of occupants and kind of equipment installed in the room.

3.2.4.3 The number of air changes per hour provided for any room is dependent upon the number ofoccupants. The air should be changed at the rate of $1{\cdot}5\,m^3/min$ per person and not less than $0{\cdot}3\,m^3/min$ of this air should come from outside sources.

3.2.4.4 The number of air changes per hour provided for rooms containing equipment generating heat shall necessarily be increased, depending on the amount of heat to be carried out by the ventilating system.

3.2.4.5 For medium climates, the maximum temperature rise of air carrying off heat of transformers should be limited to 20°C, and for hot climates the temperature rise shall be limited to 16°C ; however, the final temperature of the air exhausted shall not exceed 45°C.

3.2.4.6 Air supplied to rooms containing special mechanical or electrical equipment should be filtered aridcirculation maintained at a minimum, through diffusers, to prevent the accumulation of dust on sensitive mechanisms. The relative humidity of air supplied should not be higher than 65 percent.

3.2.4.7 Rooms which may contain air contaminated with objectionable or harmful odours, carbon dioxide gas or smoke, should be exhausted directly to the outside of the building.

3.2.4.8 When heating or cooling units are provided in the power house, their effect on the quantity and temperature or air circulating through the building shall be considered.

-3.2.4.9 The spacing of supply and exhaust openings in long rooms or galleries should be such that sufficient air changes per hour are provided along the full length of the room.

4. FANS

4.1 Forced air ventilation is provided by propeller, axial or centrifugal type fans powered by electric motors. Propeller fans may be used either to supply or exhaust where no duct system, filters or other restrictions are in the air passage. When duct system is used, axial or centrifugal fans may be used for any type of operation involving the movement of air and may be accompanied by filters, and coolers or heaters where cleaning and tempering of supply air is required. Choice of a particular type of fan may be made by consulting the fan manufacturers data, which give full operating characteristics with a preferred range of operation for a particular fan.

5. AIR INTAKE AND EXHAUST -OPENINGS

5.1 Openings are provided for intake and exhaust of air where outside air is required for ventilation. Where natural ventilation is used, the opening of windows is sometimes sufficient. For forced ventilation, special openings are required. The number of openings for intake and exhaust of air depends on the space arrangement in the building, on the size of the building and the design of the ventilation system. Small

power plants may have one opening of each type. For larger power plants, separate outside air intake should be installed for the control, service and main unit bays. Each intake should be provided with storm louvers, screens, and dampers for controlling the mixture of outside and circulated air. The obstructive effect of the louvers should be compensated for by making the gross area of the initial intake twice the area of the connecting duct. When filters are used, the area shall be increased to accommodate the required filter area.

5.2 Air opening may be placed any where on the exposed walls or roof of the power plant building, except that, in order to reduce dust intake, air intake should be at least 1·25 m above ground or deck level.

5.3 Air is exhausted from the building through exhaust openings provided with louvers or by axial-flow exhaust fans located near the roof in the main generator room. Normally, the number of exhaust openings may be more than the air inlet openings, since the spaces to be exhausted are seldom located in the same general area, nor do they have common requirements. Individual centrifugal fans and connecting ducts are usually installed to exhaust air from toilets, battery rooms and oil storage rooms.

5.4 The size of air openings is dependent on noise level, and to a lesser degree, on horse power requirements, since the smaller the opening the higher will be the noise level and the resistance. The size of air openings may also be worked out from the air velocity as recommended in Table 2, which will be found to give satisfactory results in designing conventional systems.

6. AIR CLEANING

6.1 It is desirable to clean the air entering the power plant building in order to remove the air-borne dust particles which, if allowed to enter the building, may have an abrasive effect on rotating machinery, interfere with the operation of electric or electronic devices, and may, otherwise settle on equipment, giving a dirty appearance. The air filters are usually located upstream of the fan. The size of the air filters may be determined by the recommended velocity of air passing as given in Table 2. The choice of the air filter may be made by reference to the manufacturer's catalogues.

7. AIR-CONDITIONING

7.1 When the desired temperatures and humidities inside the hydel power station are not obtainable by ordinary ventilation, air-conditioning may be resorted to by heating or cooling the entering air to the desired temperature to maintain comfortable working conditions in the premises occupied by working personnel. The premises where it will be desirable

TABLE 2 RECOMMENDED AND MAXIMUM DUCT VELOCITIES FOR SYSTEMS IN POWER HOUSE BUILDINGS

(Clauses 5.4 *and* 6.1)

SL No.	DESIGNATION	RECOMMENDED VELOCITIES m/min	MAXIMUM VELOCITIES m/min
(1)	(2)	(3)	(4)
i)	Outer air intakes	150	370
ii)	Filters*	110	110
iii)	Heating coils*	180	210
iv)	Air washers	150	150
v)	Fan outlets	500-730	850
vi)	Main ducts	370-550	670
vii)	Branch ducts	250-300	550
viii)	Branch risers	250	500

***These velocities are for total face area and not the net free area;** other velocities in the table are for net free area. The net free area is the total minimum area of the opening in the face of a coil, grille, register or louver through which air can pass.

to provide air-conditioning are control. room, machine shop, offices, reception room, first-aid room, dark room, electrical laboratory, switchgear and terminal board room and telephone and carrier communication room. For air-conditioning reference may be made to IS : 659-1964* and IS : 660-1963†.

7.2 In general, all rooms, used by sedentary personnel shall be maintained at 22°C with a relative humidity of about 50 percent, or in special cases local radiant type portable heaters may be used for the space actually occupied. Operation of the air-conditioning system should be independent of the main ventilating system and the control of the system should be automatic by means of thermostatic devices. Heating and cooling load computations may be based on currently accepted standard practice.

8. DUCTS

8.1 Where positive ventilation requires ducts for proper air distribution, considerable advantage may be achieved by incorporating the ducts into the building structure and by having the interior surfaces carefully finished to render them smooth and air-tight.

*Safety code for air-conditioning (*revised*).

†Safety code for mechanical refrigeration (*revised*).

8.2 Where metal duct work is installed, it shall be fabricated from galvanized steel or aluminium sheets, and shall conform to IS : 655-1963*.

8.3 The transfer of air by ducts; from source to delivery point, should be as direct as practicable with the fewest possible bends. Flexible connections shall be provided between fans and duct work to prevent the noise of fan vibration being transmitted directly to the sheet-metal ducts.

8.4 The size of the air ducts shall be worked out from the permissible air velocities given in Table 2.

8.5 Supply and exhaust ducts of acid battery rooms shall be painted with acid resistant paint both inside and outside.

8.6 Ducts shall be suitably insulated wherever required.

9. AIR DISTRIBUTION CONTROL

9.1 To regulate the flow of air in a ventilating system, control dampers shall be provided throughout. At outside air intakes, multi-louver dampers shall be used to control the amount of air admitted. A similar damper is required on inside air intakes to control the amount of recirculated air. These two dampers shall be interconnected to permit regulation of the proportion of outside air to inside air used in the ventilating system. These may be operated manually or automatically. Back-draft dampers are used where it is desired to prevent a reverse flow of the air, such as the air supply duct to a battery room. Exhaust ducts from rooms containing a fire hazard shall have dampers which can be automatically and manually closed in case of fire. Discharge openings, provided with propeller exhaust fans, should be fitted with motor or mechanically operated type multi-louver dampers, which will open and close automatically when the fan motor starts and stops.

*Specification for metal air ducts (*revised*).